Chapter 12: Group 17

Homework marking scheme

1 a i The relative atomic mass is the weighted mean mass of an atom of an element [1]
relative to 1/12 [1]
the mass of an atom of ^{12}C. [1]

ii relative atomic mass = $\frac{(84 \times 0.56) + (86 \times 9.86) + (87 \times 7.0) + (88 \times 82.58)}{100}$ [1]
= 87.7 (lose 1 mark if not stated to 1 decimal place) [2]

iii chemical reactions are identical as electron arrangements are the same [1]
physical properties will be slightly different as atoms are different masses; could be radioactive [1]

b Br^- [1]
The reaction with silver nitrate solution [1]
and the reddish-brown gas formed with concentrated sulfuric acid
indicates bromine is formed [1]
and the source of this must have been bromide ions. [1]
$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$ (note state symbols are essential here) [1]
$2Br^- + 4H^+ + SO_4^{2-} \rightarrow Br_2 + SO_2 + 2H_2O$ [1]

c This solution would go from colourless to reddish-brown. [1]
When the solution was shaken with cyclohexane this reddish-brown colour would fade and the cyclohexane layer would go reddish-brown. [1]
$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$
balancing [1]
state symbols (can allow $Br_2(l)$) [1]

2 a $n(I_2) = ½\ n(S_2O_3^{2-}) = ½ \times 32 \times 10^{-3} \times 0.1 = 1.6 \times 10^{-3}$ mol [1]
mass of iodine = $n \times M_r = 1.6 \times 10^{-3} \times 253.8 = 0.406$ g [1]

b i SO_4^{2-} [1]
$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
balanced ionic equation [1]
with state symbols [1]

ii Br^- [1]
$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$
balanced ionic equation [1]
with state symbols [1]

iii H^+ [1]

c $4Br_2 + S_2O_3^{2-} + 5H_2O \rightarrow 8Br^- + 2SO_4^{2-} + 10H^+$
reactants ($4Br_2 + S_2O_3^{2-}$) [1]
water [1]
products [1]
balancing [1]

d The oxidation state of the bromine decreases from 0 to −1 [1]
therefore, it has been reduced. [1]
The oxidation state of the sulfur in the thiosulfate increases from +2 to +6 [1]
therefore, it has been oxidised; hence this is a redox reaction. [1]

3 a i Br atom: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$ [1]

ii Br^- ion: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ [1]

iii The positive nuclear charge remains the same [1]

the number of electrons increases [1]

therefore, the attractive pull on each electron decreases, leading to increased radius. [1]

b i Chlorine displaces bromine from its compounds because it is more reactive/ it is a stronger oxidising agent [1]

$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$

balancing [1]

state symbols: allow $Br_2(l)$ [1]

ii $n(Br_2 \text{ formed}) = n(Cl_2)$ [1]

$= \frac{20 \times 10^3}{24} = 833.3 \text{ mol}$ [1]

mass of bromine = 833.3 × 79.9 = 66580 g (= 66.58 kg) [1]

c i $Br_2 + 6OH^- \rightarrow Br^- + BrO_3^- + 3H_2O$

correct reactants and products [1]

balancing [1]

ii Stage I: $Br_2 + 2OH^- \rightarrow 2H_2O + Br^- + BrO^- + H_2O$

correct reactants and products [1]

balancing [1]

Stage II: $3BrO^- \rightarrow 2Br^- + BrO_3^-$

correct reactants and products [1]

balancing [1]